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COAL-MINE EXPLOSIONS AND COAL- AND METAL-MINE FIRES IN THE UNITED STATES DURING THE FISCAL YEAR ENDED JUNE 30, 1941

BY

D. HARRINGTON AND W. J. FENE

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COAL-MINE EXPLOSIONS AND COAL- AND METAL-MINE FIRES IN THE UNITED STATES DURING THE FISCAL YEAR ENDED JUNE 30, 1941[1]

By D. Harrington[2] and W. J. Fene[3]

INTRODUCTION

The record of fatalities from mine explosions during the past 2 fiscal years has been anything but encouraging; more men were killed by explosions (379) than were killed from the same cause during the preceding 6 years combined (368).

The reason for the large increase in the number of explosion fatalities during the past 2 years as compared with the previous 6 years is not entirely clear. In some instances, there has been laxity in the enforcement of State mining laws; in others, both workers and operating officials have failed to observe recognized precautionary measures to prevent explosions. In many of the explosions that have occurred within the past few years in mechanized mines it has been evident that speed of operation and a demand for maximum tonnage at minimum cost resulted in neglect of ordinary safety measures.

SUMMARY OF MINE EXPLOSIONS, BY STATES AND CAUSES

Table 1 summarizes essential data on 26 explosions that were known to have occurred in 11 States and resulted in 163 deaths during the fiscal year ended June 30, 1941. It contains information on all coal-mine explosions in the United States during the fiscal year that were brought to the attention of the Bureau of Mines and is believed to cover every explosion in which life was lost or considerable damage was caused. The 26 explosions that occurred during the past fiscal year were 8 more than the number known to have occurred during the previous year, and the number of deaths (163) was 43 less than in the previous fiscal year, when 206 fatalities were caused by coal-mine explosions.

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7208."

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TABLE 1. - Summary of coal-mine explosions, by States and causes, fiscal year ended June 30, 1941[1]

State	Lighting used			Fatalities, by ignition causes									
	Open	Closed	Unknown	Electricity		Open lights or smoking		Explosives		Miscellaneous or unknown		Total	
				Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions	Deaths	Ignitions
Alabama	2	3	-	5	1	1	4	-	-	-	-	6	5
Arkansas	-	1	-	10	1	-	-	-	-	-	-	10	1
Colorado	-	1	-	-	-	-	-	2	1	-	-	2	1
Illinois	-	1	-	-	1	-	-	-	-	-	-	0	1
Indiana	-	3	-	16	3	-	-	-	-	-	-	16	3
Ohio	-	2	-	31	1	1	1	-	-	-	-	32	2
Oklahoma	1	-	-	-	-	-	-	1	1	-	-	1	1
Pennsylvania	1	4	-	75	4	1	1	-	-	-	-	76	5
Tennessee	1	1	-	-	-	1	1	-	1	-	-	1	2
Utah	-	1	-	1	1	-	-	-	-	-	-	1	1
West Virginia	-	4	-	7	2	11	2	-	-	-	-	18	4
Total	5	21	-	145	14	15	9	3	3	-	-	163	26

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[1] Includes data on all coal-mine explosions in the United States insofar as could be ascertained by the Safety Division of the Bureau of Mines.

The greatest number of deaths from explosions in any State during the past fiscal year occurred in Pennsylvania (76); Ohio had 32 fatalities, West Virginia 18, Indiana 16, Arkansas 10, Alabama 6, Colorado 2, and Oklahoma, Tennessee, and Utah 1 each. Alabama and Pennsylvania had 5 explosions each; West Virginia had 4, Indiana 3, Ohio and Tennessee 2 each, and Arkansas, Colorado, Illinois, Oklahoma, and Utah 1 each.

The 8 major explosions during the year resulted in 144 deaths; during 1940 there were 3 major explosions and 191 deaths; and during 1939 there were no major explosions. (A major explosion is one in which 5 or more fatalities occur). Six of the 26 explosions known to have occurred during the past year did not result in fatalities. The anthracite mines of Pennsylvania (many of which are extremely gassy), employing approximately 100,000 men and yielding 40 to 50 million tons of coal have the very good record of operating more than 3 years without a major explosion.

Table 2 summarizes the causes of explosions that occurred during the fiscal years 1929 to 1941, as determined from records of the Safety Division of the Bureau of Mines. It shows that 145 persons were killed during the past fiscal year in explosions initiated by electricity, compared with 99 in the previous year and an average of 57.1 per year for the preceding 12 years. Deaths from explosions due to electricity increased more than 46 percent compared with the previous year and more than 154 percent compared with the average for the previous 12 years. There were 14 explosions of electrical origin during the fiscal year 1941 compared with six such explosions during the previous fiscal year and an average of 14.2 during the previous 12 fiscal years. Pennsylvania had 4 explosions caused by electricity, with 75 deaths, in the past year; Indiana had 3, with 16 deaths; West Virginia 2, with 7 deaths; Alabama 1, with 5 deaths; Arkansas 1, with 10 deaths; Ohio 1, with 31 deaths; Utah 1, with 1 death; and Illinois 1, with no deaths.

During the fiscal year 1941, 9 mine explosions were caused by open lights and smoking compared with 5 during the previous year and an average of 9.3 during the previous 12 years. Fifteen deaths resulted from explosions caused by open lights and smoking during 1941 compared with 2 deaths from this cause in 1940 and an average of 24.2 during the previous 12 years. Alabama had 4 explosions with 1 death caused by open lights or smoking; Ohio, Pennsylvania, and Tennessee had 1 explosion with 1 death, each; and West Virginia had 2 explosions with 11 deaths. In 3 of these explosions, gas was ignited by carbide lamps; 5 explosions, with 13 deaths, resulted from attempts to smoke in closed-light mines, and 1 explosion and 1 death resulted when a fireboss attempted to relight his flame safety lamp with a match in the presence of gas.

TABLE 2. - Summary of data on explosions, by causes, fiscal years 1929-41[1/]

Year	Lighting used			Fatalities, by causes of ignition									
	Open	Closed	Un-known	Electricity		Open lights or smoking		Explosives		Miscellaneous or unknown		Total	
				Deaths	Igni-tions	Deaths	Igni-tions	Deaths	Igni-tions	Deaths	Igni-tions	Deaths	Igni-tions
1929	18	19	1	93	18	14	11	26	8	6	1	139	38
1930	8	25	1	154	18	21	8	24	6	-	2	199	34
1931	12	14	-	143	9	56	11	18	6	-	-	217	26
1932	15	14	4	11	10	33	15	42	5	1	3	87	33
1933	7	14	1	25	8	63	8	29	4	5	2	122	22
1934	9	14	3	21	10	2	9	2	3	3	4	28	26
1935	6	17	-	29	10	6	9	3	2	16	2	54	22
1936	15	9	1	20	5	10	17	4	1	4	2	38	25
1937	4	12	4	53	12	3	5	-	1	6	2	62	20
1938	10	16	3	24	10	77	11	61	6	8	2	170	29
1939	2	12	-	13	9	2	3	-	-	1	2	16	14
1940	6	11	1	99	6	2	5	103	5	2	2	206	18
1941	5	20	-	145	14	15	9	3	3	-	-	163	26
Total	117	197	19	830	139	304	121	315	50	52	24	1,501	333

[1/] The fiscal year ends June 30.

Three explosions resulting in 3 deaths were caused by explosives during the past fiscal year compared with 5 explosions and 103 deaths during the previous fiscal year and an average of 4 explosions and 26 deaths during the previous 12 years.

No explosions were reported during the year in which the cause was listed as unknown or of a miscellaneous nature.

RECORD OF EXPLOSIONS, BY STATES

Table 3 shows the record of explosions, by States, for the past 13 fiscal years. During this 13-year period, 333 explosions caused 1,501 deaths, an average of 115.5 deaths and 25.6 explosions per year. The number of explosions occurring during the past fiscal year about equals the average for the preceding 12 years, and the number of deaths (163) is about 21 percent less than for 1940 (206 deaths); however, it was about 31 percent more than the average (115.5) for this period. For the 13-year period, Pennsylvania had the greatest total number of explosions - 93, with 296 deaths. West Virginia had 60 explosions with 263 deaths. Ohio, with only 13 explosions, had the next largest number of deaths (202). It is encouraging to note that during the 13-year period Kansas and Maryland are reported to have had only one explosion each with a total of 3 deaths (2 in Kansas and 1 in Maryland). Kentucky, a large producing State, had no explosions during the fiscal year 1941, and New Mexico had not reported an explosion during the past 8 years.

The average number of deaths per explosion during the past 13 years has been 4.50, with a range for the States of 0.28 in Tennessee to 15.54 in Ohio. States with the highest averages are Ohio, 15.54; Alaska, 14.00; Oklahoma, 8.66; and Virginia, 8.60. It is noteworthy that in these States relatively little attention has been given to the use of closed lights, permissible explosives, rock dusting, and precautions with electrical equipment. During the past year, Ohio revised its mining laws to provide more definitely for these safety precautions. The following coal-producing States are not listed in table 3, as they are not known to have had an explosion during the past 13 years: Iowa, Michigan, Missouri, Montana, North Dakota, and Texas. This is a marvelous record, even if these States are by no means heavy producers of coal.

CAUSES OF EXPLOSIONS

Table 4 gives data on causes of explosions in the United States during the past 13 years as reported to the Safety Division of the Bureau of Mines by its representatives. In all, 333 explosions were studied during the 13-year period, an average of 25.6 explosions per year. There were 26 explosions during the past fiscal year, or 8 more than during the previous year and about equal the average of the preceding 12 years.

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TABLE 3. - Record of explosions, by States, during fiscal years 1929-41[1]

State	1929		1930		1931		1932		1933		1934		1935		1936		1937	
	Deaths	Igni-tions	Deaths	Igni-tions	Deaths	Igni-tions	Deaths	Igni-tions	Deaths	Igni-tions	Deaths	Igni-tions	Deaths	Igni-tions	Deaths	Igni-tions	Deaths	Igni-tions
Alabama	13	7	8	4	-	2	4	5	-	-	2	2	-	1	-	1	-	-
Alaska	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arkansas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	1
California	-	1	7	2	12	1	-	1	-	1	-	-	-	-	-	-	-	-
Colorado	-	-	-	1	-	-	4	3	1	1	-	-	-	-	12	2	1	1
Illinois	-	3	10	2	2	1	3	3	54	1	-	-	-	-	-	-	-	-
Indiana	-	-	-	-	28	1	-	-	4	2	-	-	-	-	2	3	-	-
Kansas	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kentucky	11	3	16	1	-	-	3	1	26	2	-	1	1	1	9	1	-	-
Maryland	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
New Mexico	-	-	-	-	8	3	-	-	14	1	-	-	-	-	-	-	-	-
Ohio	3	3	1	2	88	3	-	-	-	-	-	-	-	-	4	1	-	-
Oklahoma	1	1	71	4	45	2	-	-	3	2	-	-	3	2	-	-	3	1
Pennsylvania	70	9	16	8	23	7	7	6	9	6	16	14	24	11	8	10	14	5
Tennessee	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	1
Utah	1	2	30	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Virginia	2	1	-	-	-	-	54	3	-	-	2	3	18	2	-	-	2	1
Washington	-	-	17	2	-	2	-	-	2	1	-	2	-	-	-	4	1	2
West Virginia	36	7	23	5	11	4	11	7	9	5	8	4	5	4	3	3	36	8
Wyoming	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	-
Total	139	38	199	34	217	26	87	33	122	22	28	26	54	22	38	25	62	20

[1] The fiscal year ends June 30.

TABLE 3. - Record of explosions, by States, during fiscal years 1929-41[1] (Cont'd.)

State	1938		1939		1940		1941		Total, 13 years		Average per year		Average deaths per ignition
	Deaths	Igni-tions	Deaths	Igni-tions	Deaths	Igni-tions	Deaths	Igni-tions	Deaths	Igni-tions	Deaths	Igni-tions	
Alabama	37	2	-	1	1	4	6	5	71	34	5.5	2.6	2.09
Alaska	14	1	-	-	-	-	-	-	14	1	1.1	.08	14.00
Arkansas	4	4	-	-	3	1	10	1	22	7	1.7	.5	3.14
California	-	-	-	-	-	-	-	-	19	6	1.5	.5	3.17
Colorado	-	-	-	-	1	1	2	1	21	10	1.6	.7	2.10
Illinois	5	2	1	1	1	1	0	1	76	15	5.8	1.1	5.06
Indiana	22	2	-	-	-	-	16	3	72	11	5.5	.8	6.54
Kansas	-	-	-	-	-	-	-	-	2	1	.2	.08	2.00
Kentucky	-	2	1	1	28	1	-	-	95	14	6.1	1.0	6.08
Maryland	-	-	-	-	-	-	-	-	1	1	.08	.08	1.00
New Mexico	-	-	-	-	-	-	-	-	22	4	1.7	.3	5.50
Ohio	2	1	-	-	72	1	32	2	202	13	15.5	1.0	15.54
Oklahoma	-	-	1	1	2	1	1	1	130	15	10.0	1.1	8.66
Pennsylvania	30	7	3	3	-	2	76	5	296	93	22.8	7.1	3.10
Tennessee	-	-	-	-	1	1	1	2	2	7	.15	.5	.28
Utah	-	-	-	-	-	-	1	1	32	6	2.4	.4	5.33
Virginia	46	3	4	1	1	1	-	-	129	15	9.9	1.1	8.60
Washington	-	1	-	2	1	2	-	-	21	18	1.6	1.3	1.24
West Virginia	5	3	6	4	95	2	18	4	266	60	20.5	4.6	4.43
Wyoming	5	1	-	-	-	-	-	-	8	2	.6	1.5	4.00
Total	170	29	16	14	206	18	163	26	1,501	333	115.5	25.7	4.52

See footnote page 6.

TABLE 4. - Comparison of explosions by ignition causes, fiscal years 1929-41, inclusive

Year	Ignition by electricity		Ignition by open lights or smoking		Ignition by explosives		Ignition due to unknown or miscellaneous causes		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1929	13	47.4	11	29.0	8	21.0	1	2.6	38	100
1930	18	52.9	8	23.5	6	17.6	2	6.0	34	100
1931	9	34.6	11	42.3	6	23.1	-	-	26	100
1932	10	30.3	15	45.5	5	15.1	3	9.1	33	100
1933	8	36.4	8	36.4	4	18.1	2	9.1	22	100
1934	10	38.5	9	34.6	3	11.5	4	15.4	26	100
1935	10	43.5	9	39.1	2	8.7	2	8.7	23	100
1936	5	20.0	17	68.0	1	4.0	2	8.0	25	100
1937	12	60.0	5	25.0	1	5.0	2	10.0	20	100
1938	10	34.5	11	37.9	6	20.7	2	6.9	29	100
1939	9	64.3	3	21.4	-	-	2	14.3	14	100
1940	6	33.3	5	27.8	5	27.8	2	11.1	18	100
1941	14	53.8	9	34.6	3	11.6	-	-	26	100
Total	139	41.6	121	36.2	50	15.0	24	7.2	334	100
Average	10.7	41.6	9.1	36.2	3.8	15.0	1.8	7.2	25.7	100

Table 4 shows that electricity was responsible for 139 (41.6 percent) and open lights or smoking for 120 (36.0 percent) of the explosions listed for the 13 years; hence, 77.8 percent of all known explosions during this 13-year period were started by ignitions due to electricity, open lights, and smoking.

The number of explosions of electrical origin during the past year (14) is about 26 percent more than the average for the preceding 12 years (10.4), whereas the number caused by open lights and smoking (9) about equals the average (9.3) from these causes for the preceding 12 years. Evidently electricity is becoming increasingly important as an initiator of explosions in our coal mines.

Table 4 shows that 3 explosions were caused by explosives during the past year compared with 5 in the previous year and an average of 2.9 for the preceding 12 years.

No explosions are listed under unknown or miscellaneous causes.

EXPLOSION FATALITIES, BY CAUSES

Table 5 compares explosion fatalities by causes and shows that during the past 13 years 1,501 fatalities resulted from explosions in the United States, an average of 115.5 a year. Although the record of explosion fatalities during the fiscal year 1941 was somewhat less than for the preceding year, the number is well above the average for the 13-year period. Eight major explosions during the year resulted in 144 deaths, and 18 minor explosions in 19 deaths, compared with the record for the fiscal year 1940, when 3 major explosions and 191 deaths and 15 minor explosions with 15 deaths occurred. The record of major explosions during the past 2 years is one in which the coal-mining people can take very little pride.

Explosions of electrical origin were responsible for 145 (89 percent) deaths from explosions during the past fiscal year. This represents a marked increase over the 99 deaths from this cause during the previous year and the average of 57 deaths for the preceding 12 years. All of the major (8) and 6 of the minor explosions were caused by electricity. The experience of 1941 bears out the statement made before in these circulars, "that explosions of electrical origin will continued to occur if haphazard methods in the use of electrical equipment are continued." With the rapid extension of mechanized mining, chiefly by electrically operated equipment, the least that should be done in the cause of safety is to use only the safest types, and this means permissible equipment maintained in permissible condition. Moreover, a higher type of personnel should be employed in connection with the installation, use, inspection, and repair of electrical installations and equipment than has been done in the United States up to the present time.

TABLE 5. - Comparison of explosion fatalities by causes of ignition, fiscal years 1929-41, inclusive

Year	Ignition by electricity		Ignition by open lights or smoking		Ignition by explosives		Ignition due to unknown or miscellaneous causes		Total	
	No. killed	Percent	No. killed	Percent	No. killed	Percent	No. killed	Percent	No. killed	Percent
1929	93	66.9	14	10.1	26	18.7	6	4.3	139	100
1930	154	77.4	21	10.5	24	12.1	-	-	199	100
1931	143	65.9	56	25.8	18	8.3	-	-	217	100
1932	11	12.7	33	37.9	42	48.3	1	1.1	87	100
1933	25	20.5	63	51.6	29	23.8	5	4.1	122	100
1934	21	75.0	2	7.1	2	7.1	3	10.8	28	100
1935	29	53.7	6	11.1	3	5.6	16	29.6	54	100
1936	20	52.6	10	26.4	4	10.6	4	10.5	38	100
1937	53	85.5	3	4.8	-	-	6	9.7	62	100
1938	24	14.1	77	45.3	61	35.9	8	4.7	170	100
1939	13	81.3	2	12.5	-	-	1	6.2	16	100
1940	99	48.3	2	1.0	103	49.7	2	1.0	206	100
1941	145	89.0	15	9.1	3	1.9	-	-	163	100
Total	830	55.5	304	20.2	315	20.9	52	3.4	1501	100
Average	63.9	55.5	23.3	20.2	24.22	20.9	4.0	3.4	115.4	100

Two explosions occurred in the same mine within 2 weeks, resulting in the death of 2 men in the first explosion and of 14 men in the second. Both explosions were caused by gas ignited by nonpermissible mining machines. Something is definitely wrong in a mine that has two explosions from the same cause within 2 weeks.

Open lights and smoking resulted in 15 deaths or 9.1 percent of the fatalities due to explosions during the past fiscal year compared with 2 deaths (1.0 percent) for the previous year and to an average of 24 deaths during the preceding 12 years. Carbide lamps were responsible for 2 explosions and 1 death, smoking resulted in 6 explosions and 13 deaths, and a fireboss was killed when he attempted to relight his flame safety lamp in the presence of gas. The hazards of the use of open lights and nonpermissible flame safety lamps are so obvious that it is difficult to understand the reasoning of operators and employers who continue to use such equipment and practices. Smoking in coal mines, especially in closed-light mines, denotes a callous attitude by the smoker and a woeful lack of enforcement of discipline by mine-operating officials.

During the past 13 years, 315 deaths (20.9 percent of all deaths due to explosions) resulted from the use of explosives. In the past fiscal year, 3 deaths resulted from such explosions compared with 103 deaths from this cause during the previous year and an average of 26 for the preceding 12 years. Of the three explosions caused by explosives during the past year, two were of dust, which resulted from blown-out shots of black powder, and one was caused by igniting gas with a fuse lighter. The use of black blasting powder of any type in any coal mine for any purpose indicates that both employer and employee are willing to gamble with human life and limb for the purpose of continuing in a rut rather than have the courage to change from black powder.

ELECTRICAL CAUSES OF EXPLOSIONS

Table 6 gives data available to the Bureau of Mines on causes of explosions of electrical origin in the United States for the past 13 years. During this period there were 139 explosions of electrical origin, of which 14, with 145 deaths, occurred during the past fiscal year.

Trolley or cable-reel locomotives and nonpermissible mining machines jointly were responsible for at least half of the explosions of electrical origin in the coal mines of the United States during the 13-year period and for more than half of the explosions of electrical origin that occurred during the past year.

During the past year, trolley locomotives were responsible for 3 explosions, nonpermissible mining machines for 4 explosions, nonpermissible electric drills for 3 explosions, and a nonpermissible electric motor, cable wire, trolley wire, and an electric arc were responsible for 1 each.

TABLE 6. - Electrical causes of explosions, fiscal years 1929-41, inclusive

	Explosions of electrical origin, by fiscal years													Total, 13 years	Number killed	
	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941		1940	1941
Trolley or cable-reel locomotive[1]	5	5	1	1	4	5	3	1	5	4	3	-	3	39	-	67
Nonpermissible mining machines[2]	5	5	3	3	1	-	2	1	3	3	-	2	4	31	6	28
Nonpermissi- electric motor	4	3	-	-	-	-	2	-	-	1	2	-	1	13	-	1
Nonpermissible shot-firing battery or circuit	-	[3]2	[3]3	1	-	1	-	-	-	-	-	-	-	2	-	-
Cable nips at blow-out	-	2	-	-	-	1	-	-	1	-	1	-	1	6	-	5
Nonpermissible electric drill	-	-	-	2	-	1	2	-	-	-	2	2	3	12	1	36
Nonpermissible storage-battery locomotive	1	1	2	-	-	-	-	-	-	-	-	-	-	4	-	-
Nonpermissible electric hoist	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
Faulty wiring	2	2	-	-	-	-	-	1	1	-	-	-	-	6	-	-
Trolley wire	1	-	2	1	-	-	-	1	-	-	-	-	1	6	-	1
Electric arc	2	-	1	2	1	2	1	[4]1	1	2	1	2	1	17	92	7
Signal wire	-	-	-	-	1	-	-	-	1	-	-	-	-	2	-	-
Total	18	18	9	10	8	10	10	5	12	10	9	6	14	139	99	145

[1] 1 not included in total; may have been from open light. [2] 1 not included in total; may have been from smoking. [3] Not included in total; may have been from overcharged shot. [4] Included, but may have been from smoking.

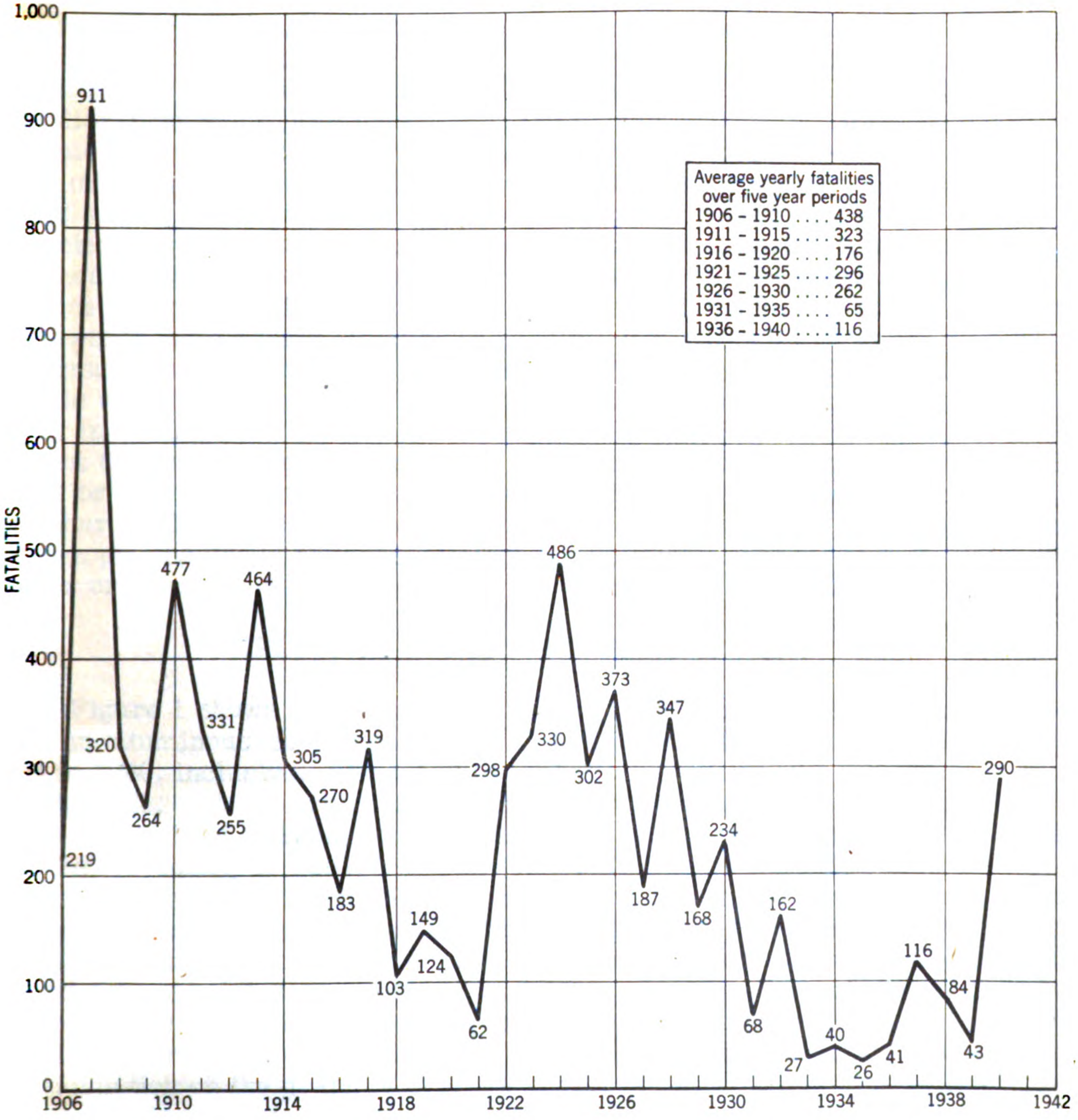
Most coal-mine explosions of electrical origin during the past 13 years have shown evidence of carelessness or flagrant disregard of safe ventilation practices, such as leaving doors open (generally latched open) on main or important haulage entries; permitting line brattices to be in poor condition or not extended close enough to the face; inadequate ventilation by blower fans (this being manifested in numerous different ways); coursing of air through or past partly caved, more or less inaccessible, and hence poorly ventilated workings; or other manifestations of neglect to control the air currents through and past mine workings. Other factors in these electrical ignitions of gas and dust were: (1) Failure to test for gas before going into working places with electrical equipment such as mining machines, electric locomotives, loading machines, or electric drills, or failure to test from time to time while using this equipment; (2) use of electrical equipment too soon after the mine fan has been started after a shut-down; (3) failure to examine a mine properly on idle days, when only a skeleton crew is in the mine; (4) use of haulageways as return airways, a practice that is always hazardous in the extreme, whether in gassy or nongassy mines; (5) failure to install and utilize permissible electrical equipment or to maintain permissible electrical equipment in a safe or permissible condition; (6) haphazard methods of making cable splices and in attaching cable nips to power wires; and other heedless and careless practices in connection with coal-mine procedures directly or indirectly involving ventilation.

COMPARISON OF LIGHTING IN MINES WHERE EXPLOSIONS OCCURRED

Table 7 indicates the method of lighting in mines where explosions occurred during the past 13 years. Of the 333 explosions that have occurred during this period, 117 (34.8 percent) were in open-light mines, 198 (59.4 percent) were in closed-light mines, and 19 (5.7 percent) were in mines in which the lighting practice is unknown. During the past fiscal year 5 (19.2 percent) of the explosions occurred in open-light mines compared with an average of 9.3 explosions per year in open-light mines during the preceding 12 years.

TABLE 7. - Comparison of lighting in mines where explosions occurred, fiscal years 1929-41, inclusive

Year	Open lights		Closed lights		Lighting unknown		Total	
	No. of explosions	Percent	No. of explosions	Percent	No. of explosions	Percent	No. of explosions	Percent
1929	18	47.4	19	50.0	1	2.6	38	100
1930	8	23.5	25	23.5	1	3.0	34	100
1931	12	46.2	14	53.8	-	-	26	100
1932	15	45.5	14	42.4	4	12.1	33	100
1933	7	31.8	14	63.6	1	4.6	22	100
1934	9	34.6	14	53.7	3	11.5	26	100
1935	6	26.1	17	73.9	-	-	22	100
1936	15	60.0	9	36.0	1	4.0	25	100
1937	4	20.0	12	60.0	4	20.0	20	100
1938	10	34.5	16	55.2	3	10.3	29	100
1939	2	14.3	12	85.7	-	-	14	100
1940	6	33.3	11	61.1	1	5.6	18	100
1941	5	19.2	21	80.8	-	-	26	100
Total	11.7	35.0	198	59.3	19	5.7	333	100



Average yearly fatalities over five year periods	
1906 - 1910	438
1911 - 1915	323
1916 - 1920	176
1921 - 1925	296
1926 - 1930	262
1931 - 1935	65
1936 - 1940	116

Figure 1.- Fatalities from gas and coal-dust explosions in bituminous-coal mines.

The fact that during the past fiscal year 80.8 percent of the explosions occurred in closed-light mines and that during the past 13 years 59.4 percent of all explosions occurred in mines using closed lights may be interpreted in several ways. Probably the most nearly correct explanation is that in many States the most gassy, hence the most dangerous, mines now use closed lights. No explosion is known ever to have been caused by an electric cap lamp; this indicates that almost unquestionably there has been carelessness in other explosion-prevention practices, otherwise more than half of the coal-mine explosions in recent years would not have occurred in closed-light mines. In many mines in which closed lights have been adopted undue dependence is placed on the lamps and ventilation and other precautionary measures are neglected more or less. Among the bad practices followed in mines or parts of mines known to give off explosive gas is the use of open types of electrical equipment (pumps, drills, cutting machines, loading machines, conveyor motors, etc.), which is a flagrant violation of sane mining practice that is absolutely unnecessary and inexcusable. Use of the up-to-date permissible electric cap lamp is unquestionably one of the most effective means now known of promoting safety in mining (coal or metal), and any agency that fails to use or tries to prevent the use of electric cap lamps is woefully ignorant of mine safety requirements or is deliberately callous to the humanitarian operation of mines. On the other hand, any organization that neglects other essential safety procedures through placing undue reliance on electric cap lamps is bound to suffer disaster sooner or later.

EXPLOSIONS IN BITUMINOUS-COAL MINES

Figure 1 shows the trend of fatalities resulting from gas and dust explosions in bituminous-coal mines of the United States during the calendar years 1906 to 1940, inclusive. The trend of explosion fatalities was downward from 1907 to 1921, with a marked rise from 1922 to 1924 and a definite, steady decline from 1924 to 1935; however, the trend has been upward during the past 4 years, especially in 1937, 1938, and 1940. It is significant that in every alternate year from 1924 to 1936 the number of deaths has increased over that of the preceding year, although the general trend has been downward. A plausible explanation is that a year with a relatively low explosion-fatality record causes relaxation in efforts to prevent accidents (or at least in prevention of explosions) during the following year; conversely, a year with a high explosion-fatality record causes additional precautionary measures to be taken. The tabulation on the graph of average annual fatalities from bituminous-coal-mine explosions for 5-year periods from 1906-1910 to 1936-40 is illuminating, as it shows larger and fairly steady decrease in annual fatalities from 438 for the 5-year period 1906-1910 to 65 for the 5-year period 1931-35, a drop of 85.5 percent; however, it is also shown that during the most recent 5-year period, 1936-40, there has been an increase of more than 78 percent in explosion fatalities as compared to the previous 5-year period, 1931-35. The record for 1931-35 bolstered hopes that disastrous mine explosions in the United States were a thing of the past; however, the record of the past 2 years has shattered such hopes. The explosion record for 1940, when 290 men were killed, is one that should cause the coal-mining industry grave concern. Several factors contribute to this bad record, such as (1) the rapid increase in the use of electrical equipment at face regions, where gas is most likely to be found, (2) the increased demand for coal to supply defense industries, (3) desire of mining-machine manufacturers and mine operators to obtain maximum tonnage per machine at minimum cost, which has resulted in neglect of rudimentary precautionary measures, (4) multiple-shift operation, which does not allow time for adequate maintenance of equipment, proper rock dusting, and testing for gas by firebosses, (5) decrease in supervision due to demands on supervisors for maximum tonnage, (6) lack of effective supervision due to numerous causes, and (7) failure of both miners and mining officials to show due regard for safety in changing from hand-loading to mechanized methods.

In view of the past year's experience, and considering the fact that the demand for coal probably will increase greatly during the coming year, the outlook is not at all bright if the same types of unsafe methods and procedures are to be pursued.

MINE FIRES

Because of the highly combustible nature of coal, timber, explosives, and other materials usually present in coal mines, the potential hazard of fire is always present in every coal mine, even when the mine is classed as damp or wet and whether it is gassy or so-called nongassy. Some coals, ores, and other materials found or used in mines ignite spontaneously under certain conditions, creating a serious hazard; however, the ignition agencies that cause most mine fires are electricity, explosives, and open lights. Despite ever-present fire hazards, the mines of the United States have been fortunate during the past decade in that they have not experienced a fire that caused large loss of life; however, a number of fires have involved considerable property damage. Although much can be done to prevent mine fires, some companies still employ methods or equipment that have caused and probably will continue to cause fires in their mines; these include the use of black powder and fuse; slipshod methods of installing, using, and maintaining electrical equipment; use of open lights; smoking; and employment of numerous other loose, unsafe, or out-of-date mining equipment, methods, and practices.

During the past fiscal year 16 fires, which resulted in the death of 2 men, were called to the attention of the Bureau of Mines. Scores of other fires were detected and extinguished promptly without much damage or were handled

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quietly and not reported to the Bureau of Mines, the general public, or even to State inspection forces.

Table 8 shows that during the past fiscal year 5 fires were reported by Bureau of Mines personnel in Pennsylvania, 3 each in Illinois and Kentucky, and 1 each in Louisiana, Montana, Tennessee, Virginia, and Wyoming. Of the 16 fires, 2 were in metal mines, 1 in a salt mine, 2 in anthracite mines, and the balance in bituminous-coal mines. Two fatalities resulted from the 16 fires, 1 each in Illinois and Wyoming. Electricity caused 7 of the fires, explosives caused 3, and 6 were of miscellaneous or unknown origin. The 16 fires reported to the Bureau of Mines during the fiscal year 1941 were 11 fewer than were reported during the previous year and three fewer than the average for the preceding 10-year period.

SUMMARY

1. It is interesting to note that of the 25 major coal-mine-fire disasters, with a total of 566 fatalities since 1900, only 4 (with 29 deaths) occurred since 1921; that no major coal-mine fires occurred in the United States from 1926 to 1933, inclusive; and that 1 occurred in March 1934, with 5 fatalities, 1 in May 1935, with 6 fatalities, and 1 in August 1936, with 9 fatalities. Although the number of deaths annually caused by mine fires has decreased steadily during the past 10 years, the number of fires occurring annually has not declined materially. Coal-mine fires may be a great potential hazard and may jeopardize the lives of many men, not only those who are cut off from escape by the fire but also those engaged in fighting the fire, if the necessary precautions are not taken. The action of mine officials during several fires of the past few years clearly indicates lack of knowledge as to procedure in controlling such fires and an apparent indifference to the hazards resulting from them. Every mine should be provided with ample fire-fighting material placed at strategic places in the mine, and officials should be instructed in the proper procedure to follow in event of fire.

2. The decrease in frequency and severity of explosions in the United States during the past 30 years has been encouraging. The record for the fiscal year 1939 was the best in the history of coal mining since it became a major industry; however, the increase in frequency and severity of explosions during the fiscal years 1940 and 1941 has caused great concern to those agencies seeking to prevent such disasters. Most coal-mine explosions result from human failure by men or management to take the precautions that they know, or at least should know, are necessary to prevent such occurrences; and failure to know what those precautions are unquestionably is their own fault, as the desirable precautions have been given much publicity for the past two decades.

TABLE 8. - Summary of mine fires, by States, fiscal years 1941 and 1930-40, inclusive

				Fatalities, by cause of ignition									
	Lighting used			Electricity		Open lights		Explosives		Unknown or miscellaneous		Total	
State	Open	Closed	Unknown	Deaths	Fires	Deaths	Fires	Deaths	Fires	Deaths	Fires	Deaths	Fires
Illinois	1	2	-	1	1	-	-	-	2	-	-	1	3
Kentucky	-	1	2	-	2	-	-	-	-	-	1	-	3
Louisiana	-	-	-	-	-	-	-	-	-	-	1	-	1
Montana	-	1	-	-	-	-	-	-	-	-	1	-	1
Pennsylvania	1	2	2	-	1	-	-	-	1	-	3	-	5
Tennessee	1	-	-	-	1	-	-	-	-	-	-	-	1
Virginia	-	1	-	-	1	-	-	-	-	-	-	-	1
Wyoming	-	1	-	1	1	-	-	-	-	-	-	1	1
Total, 1941	3	8	4	2	7	-	-	-	3	-	6	2	[1] 16
1940	12	9	6	2	5	-	2	-	1	-	19	2	27
1939	9	9	2	1	8	-	1	-	3	2	8	3	20
1938	7	6	13	1	7	2	2	-	1	5	14	8	24
1937	7	4	10	9	5	-	-	-	3	2	13	11	21
1936	16	4	3	1	7	-	2	-	3	3	11	4	23
1935	7	5	14	11	11	-	1	-	-	-	14	11	26
1934	10	5	3	-	4	-	-	5	5	1	9	6	18
1933	12	6	9	-	7	-	-	-	2	2	18	2	27
1932	8	5	8	1	8	-	-	-	3	-	10	1	21
1931	12	7	5	-	7	5	3	-	5	18	9	23	24
1930	7	8	9	2	9	3	6	-	3	-	6	5	24
Total, 12 years	110	76	86	30	84	10	17	5	32	28	139	78	[2] 241

[1] Includes 2 metal-mine fires.

[2] Includes 40 metal-mine fires and 11 outcrop fires.

The past year saw a noteworthy increase in the number of explosions caused by electricity, open lights, and smoking, which might indicate that in its demand for greater production management has neglected to take proper precautions in the use of electrical equipment and that, as to smoking, both workers and officials are very definitely responsible - the management because it evidently has not exercised the right kind or amount of discipline and the workers because they have allowed fellow workers who persist in smoking to perform what is very definitely a criminal act in any mine where conditions are known to be so hazardous that smoking is prohibited.

Some of the salient points brought out by the Safety Division of the Bureau of Mines in its study of explosions and fires in the United States during the fiscal year ended June 30, 1940, are:

1. Twenty-six explosions, all but 1 in bituminous-coal mines, were studied, compared with 18 explosions in 1940 and an average of 25.7 explosions a year during the previous 12 years. This is an increase of about 31 percent over the previous year and about equals the average number for the preceding 12 years.

2. Coal-mine explosions resulted in the loss of 163 lives during the fiscal year 1941, compared with a loss of 206 lives in 1940 and an average loss of 115.5 lives in the previous 12 years. The anthracite mines of the United States, which employ about 100,000 men and produce 40 to 50 million tons of coal (much of it from mines that are decidedly gassy and difficult to ventilate) had only one explosion, with one death, last year and have operated for more than 3 years without a major explosion disaster. This is a record in which the anthracite industry should take pride. The increase from 16 killed by explosions in the fiscal year 1939 to 206 in 1940 and to 163 in 1941 certainly reflects no credit on those engaged in promoting safety in the coal-mining industry. It is significant that fatalities in coal mines from causes other than explosions are declining, whereas fatalities from explosions are increasing, which indicates that mine operators have relaxed in observing explosion-prevention measures, or that they fail to appreciate the dangers of explosions that are introduced with changed mining methods, procedures, and equipment. This appears to be the case in the bituminous-coal mines of Pennsylvania, Ohio, West Virginia, and Indiana.

3. The eight major explosions during the past fiscal year caused 144 deaths compared with three major explosions with 191 deaths in 1940. Of the eight major explosions in 1941, all but one occurred in mines that were wholly or partly mechanized. One of the mines in which major explosions occurred was reported to have been well-rock-dusted, six were reported to have been only partly rock-dusted, and one had no rock dust. Had proper rock-dusting

to prevent propagation of explosion been in effect in all these mines, the death toll undoubtedly would have been reduced greatly and possibly one or more of the explosions could have been prevented. Failure to rock-dust adequately is absolutely inexcusable, as rock-dusting is relatively inexpensive and if kept up to standard is almost certain to prevent widespread explosions.

4. Five explosions occurred in open-light mines compared with 6 in 1940 and an average of 9.3 in the preceding 12 years; 20 were in closed-light mines, compared with 11 in 1940 and an average of 14.8 during the preceding 12 years. In the fiscal year 1941, as in former years, some of the explosions in closed-light mines were caused by open flames such as matches used by smokers and the misuse of flame safety lamps and carbide lamps. Five explosions, with 13 deaths, were thought to have been caused by smoking during the past year. The persistence of the near-criminal habit of smoking in closed-light mines is deplorable, indicating that many mine workers are willing to gamble not only with their own safety but also with the safety of others. Mine officials are not always blameless because they are often indifferent to enforcement of no-smoking rules and careless in searching for smokers' articles, and in some instances they, themselves smoke in closed-light mines. Almost every year at least one explosion is caused by shot firers or officials attempting to relight their flame safety lamps with matches. An explosion of this type occurred during the past fiscal year and caused the death of a fireboss. Although the mine operator is primarily responsible for this type of explosion because he provides or permits the use of flame safety lamps of nonpermissible type, yet it is difficult to understand such carelessness by a fire boss or any other official who is supposed to know the hazards of gas. Three explosions during the past year were caused by carbide lamps compared with two such explosions during the preceding year. This cause of explosions is also one in which both workers and management are at fault, as both know, or should know, that the use of open lights in any mine, especially any coal mine, is hazardous.

5. Fourteen explosions, causing 145 deaths, were of electrical origin compared with 6 such explosions and 99 deaths in the previous year and an average of 10.4 explosions and 57.1 deaths annually for the preceding 12 years. As previously pointed out, the greatly increased use of electricity, with the necessary increase in the amount of wiring, trailing cables, and other accessories, has multiplied the hazard of electrical ignitions, largely because much of this electrical equipment is operated at or near the face region, where the maximum quantities of gas and dust are given off.

6. Three explosions, with 3 deaths, were caused by explosives during the fiscal year 1941 compared with 4 such explosions and 103 deaths in 1940 and an average of 3.9 explosions and 26 deaths annually in the preceding 12 years. The use of dynamite or black blasting powder, either in pellet or granular

form, in coal mines is a definite violation of established safe mining practice and will continue to take lives until its use is prohibited by law. Carelessness in methods or practices of using permissible explosives also is almost certain to result in disaster; in fact, carelessness in storage and use of explosives is now and always has been flagrant; and here, again, the responsibility rests jointly with workers and management.

7. Of the explosions that occurred during the past fiscal year, 24 are thought to have been initiated by gas and 2 by coal dust. In almost all of the explosions initiated by gas, it was indicated that the ventilating current had been interrupted, was not adequate, or was not directed properly; in one or more instances it was indicated that inspection had been inadequate and that the hazard of gas had been ignored.

Three of the explosions occurred in so-called nongassy mines, one of which had been operated about 40 years without gas having been detected; and in another mine classed as nongassy but in which firebosses had been employed for 12 years, gas had not been reported until the day of the explosion. As has been the case scores of times in the past, these three explosions indicate that all coal mines are potentially gassy or may become gassy unexpectedly. Ventilation practice lacks much of being efficient in many mines; very often it is neglected flagrantly, and often undue reliance is placed on electric cap lamps, permissible explosives, rock dusting, and other installations and practices that require less continuous personal attention and effort by operating officials. In many mines it has been found that operating officials are ignorant of proper ventilation requirements and do not realize or show anything like a proper respect for the hazard of gas.

One of the features of the gas ignitions in the past year as well as in every one of the past several years was the fact that the blower fan-canvas tubing combination was a factor in several of the explosions in which gas was ignited, usually in highly mechanized mines; this is nothing new or unexpected, and as long as the blower fan-canvas or other tubing combination is used in an attempt to ventilate places in which explosive gas is released explosions are certain to continue to occur. The blower fan-tubing ventilation combination has a definite place in metal mining, but it should be absolutely prohibited in coal mining.

One dust explosion was caused by a blown-out shot, and one occurred on the main intake airway, where dust from a wrecked loaded trip was ignited by an arc caused by the trolley wire touching a steel car. Both of these are old causes of explosions, and both have resulted from poor practices and installations.

The rapid extraction of coal by multiple-shift mechanical mining undoubtedly is responsible for greater liberations of gas (as well as dust). This condition demands better ventilation, more frequent inspections, and more attention to the ventilating system in general. The speed with which mechanical operations are carried on and the tendency of crews and foremen on one shift to leave necessary repairs for the following shift or to postpone them until forced to take action are not conducive to good maintenance and certainly are highly detrimental to safety. This is borne out by observation of numerous mechanically operated properties and the fact that one of the commonest hazards in the haphazard manner in which cable splices are made and maintained in many mines.

8. The frequency of explosions during the past year (26) showed a marked increase as compared with the previous year (18); however, the severity of the explosions was much lower. The average number of deaths per explosion last year was 6.2 compared with 11.4 in 1940 and 4.34 during the preceding 12 years. The increase in severity of explosions during the past 2 years is a decidedly unsatisfactory trend and indicates that adequate precautions are not being taken to prevent the spread of explosions, one of the simplest, most effective, and least expensive being rock-dusting.

9. The 163 deaths caused by explosions during the past fiscal year occurred in 11 States; 15 of the coal-producing States had no fatalities from explosions so far as is known.

10. Evidence gathered after some of these explosions revealed that the present State mining laws in many if not most of the States are not adequate to compel compliance with basic safety principles. This fact was brought out in at least four instances when State inspectors were unable, by law, to force the correction of unsafe practices that eventually resulted in disaster. This condition will be remedied to some extent by the Federal Coal Mine Inspection service, which will enlist the force of public opinion to bring into effect up-to-date safety procedures, even though the State law does not require them.

11. A study of recent explosions indicates in some instances that systems of mining designed for hand loading cannot be operated safely with mechanical methods that require more adequate ventilation as well as more drastic method of allaying or preventing dust.

12. The undesirability of using main haulageways as return airways was demonstrated after at least one explosion during the year; this has been evident for many years in metal as well as in coal mining. In this instance the lives of the men who attempted to escape were endangered, and rescue and recovery work was delayed materially because the return air contained dangerous afterdamp.

13. The facts brought out by a study of the explosions that occurred during the past year stress the importance of allaying the coal dust at its source. Mechanical mining of coal naturally produces larger amounts of fine coal dust than hand-loading methods do; therefore, the need for allaying the dust at its source is greater, and if more adequate precautions (many of which are readily available) are not taken in future to remove the hazards from coal dust in United States mines, the coal-mining industry will ultimately be burdened with heavy bills, not only in connection with explosions and fires but also in health compensation.

14. Rock dust was used in 15 of the 26 mines in which explosions occurred during the past year, but in only a few of these so-called rock-dusted mines had a sincere effort been made to do a good job. Nevertheless, rock dust is believed to have been responsible for stopping one explosion, and it may have helped to stop some of the others.

When well done, rock-dusting is definitely known to limit the extent of explosions, and a good job of rock-dusting can be kept effective in almost any coal mine for 1 cent, or in some instances possibly 2 cents, per ton of coal produced. Although this is common knowledge, many mine operators continue to do a half-way job of rock-dusting, apparently with the hope that if an explosion occurs it will not travel down the undusted back entries or other poorly dusted parts of the mine. At present probably not as many as 2 percent of the coal mines in the United States are kept adequately rock-dusted, a condition by no means creditable to the mining industry.

15. During the fiscal year 1941, 16 mine fires (including 2 metal-mine fires), with 2 deaths, were reported, compared with 27 fires and 2 deaths in 1940 and an average of 20.4 fires and 7 deaths annually for the preceding 11 years.

16. Of the 16 fires that occurred during the year, 7 were of electrical origin, 3 were caused by explosions, and 6 were of unknown or miscellaneous origin.

17. Although the number of fires reported last year decreased about 40 percent compared with the previous year, their frequency during the past decade has shown no appreciable reduction. This fact should serve as a warning; even though fatalities caused by fires have decreased in recent years, their occurrence usually causes heavy property damage and almost invariably requires considerable ultrahazardous effort in extinguishment or control. The potential hazard of fire in any mine is always serious, especially in coal mines, because a fire can precipitate an explosion. Every underground mine, coal or other, has definite fire hazards, even those that are generally wet or

that contain relatively little combustible material. These facts should be recognized, and plans should be made and carried out to handle fires quickly and safely if and when they occur.

CONCLUSIONS

This circular was compiled in essentially the same manner as were those of previous years (see Information Circulars 6178, 6419, 6540, 6680, 6761, 6819, 6870, 6927, 6986, 7048, 7092, and 7136) and embodies only facts revealed through studies by field employees of the Safety Division of the Bureau of Mines. The Bureau of Mines attempts to obtain information concerning every explosion and most fires in mines of the United States although some of the less destructive may not have been brought to its attention early enough to permit investigation. However, the Bureau rarely fails to obtain fairly complete details of mine explosions in which more than one life has been lost, or in which considerable property has been damaged; therefore, the data in these publications are relatively complete, especially as to mine explosions causing loss of more than one life.

In some instances the available information on mine fires is not as complete as that on explosions, as scores of fires undoubtedly occur every year in coal and metal mines without the knowledge of the Bureau of Mines or even the State inspection force. Mine fires occur almost daily in some coal mines, particularly at shot-firing time where black blasting powder or dynamite is used or where the coal fires spontaneously; moreover, fires of electrical origin and those caused by open lights are by no means uncommon in metal mines.

Although metal-mine fires with heavy loss of life, such as the North Butte (Montana) fire in 1917, with 163 deaths, or the Argonaut fire in California in 1923, with 47 deaths, have not occurred for many years, fires still break out in and around metal mines. Recently a fire in the head frame of a dry salt mine set fire to the shaft timbering and for a time seriously menaced the mine and caused heavy damage, though fortunately no lives were endangered.

A study of data available on mine explosions in the United States during the past 13 years reveals an encouraging reduction in the frequency and severity of such disasters until 1940. Although the records for the fiscal years 1940 and 1941 were the worst in the 13-year period, the record for the fiscal year 1939, in which no major explosion disasters occurred, was the best in the history of coal mining in the United States for at least 60 years.

The fact that three major explosions, with a total of 191 deaths occurred in 1940 and eight major explosions, with 144 deaths, in 1941 indicates lack of proper precautions to prevent widespread explosions. Seven of the eight major explosions in 1941 occurred in mechanized mines. In seven of the disasters electricity is believed to have been the initiating cause, and in the other smoking is believed to have been responsible. In most of the mines in which major explosions occurred numerous unsafe practices were in evidence; some evidently were the result of procedures thought necessary to make maximum use of mechanical loading and other equipment and to the demand for maximum tonnage at minimum cost, which resulted in the neglect of necessary safety measures.

The trend in the calendar years 1938, 1939, 1940, and 1941 (to July 1) has been exceedingly bad as regards fatalities from major disasters in mechanized bituminous-coal mines. Of the 17 major disasters with 418 fatalities during this period, 11, with 404 fatalities, occurred in mechanized bituminous-coal mines; 4, with 34 killed, in nonmechanical bituminous-coal mines; and 2, with 18 killed, in anthracite mines. In other words, about 92 percent of the fatalities from major disasters in the coal mines of the United States (both bituminous and anthracite) in this period occurred in mechanized coal mines. If the two major disasters in anthracite mines are excluded and bituminous mines only are considered, it appears that in the past 3-1/2 years more than 96 percent of the fatalities from major disasters in bituminous-coal mines of the United States have occurred in mechanized mines.

From a study of these major disasters it would appear that the general criticism of the coal-mining industry for these disasters has been the failure to take the necessary safety precautions in mechanized mines. The fact that 96 percent of the major disaster fatalities in bituminous-coal mines of the United States during the past 3-1/2 years occurred in mechanized mines, which produced about one-third of the bituminous coal of the country, seems to indicate that during this period, hand-loading mines have been doing a fairly good job in reducing major mine disasters, whereas the mechanized mines are failing to do everything possible to prevent such disasters.

The mechanization of coal mines unquestionably introduces additional hazards, although it affords numerous opportunities to obviate many types of hazards that accompany more primitive mining methods. In addition to the mechanical hazards involved in mechanized mines, there is almost invariably a considerable concentration of workers readily susceptible to injury from any untoward or unusual occurrence; moreover, the more rapid extraction of coal in mechanical loading liberates greater quantities of gas and dust in a given period than does hand loading, and the gas and dust are liberated in the presence of a greater number of sources of ignition, chiefly in connection with electrically operated equipment. Consequently, better ventilation must be provided and greater vigilance maintained in the detection of gas and elimination or neutralizing of dust. Many explosions result directly or indirectly from carelessness or infractions of rules by employees, and many of these result from unsafe methods, installations, or practices (or all three) for which the management is responsible; therefore, the prevention of explosions is not only the responsibility of the management but of the workers as well. Irrespective of responsibility, the seriousness of the situation brought about by the very bad coal-mine-explosion record of the past 3-1/2 years cannot be questioned. All persons engaged in coal mining now face the difficulty of trying to reduce the number of coal-mine disasters in this country to the exceptionally low number of the fiscal year 1939, when no major explosions occurred.